eunix: echo

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A reimplementation of `echo` for my own edification.

Contents

The `main` Function

1b ⟨*Define the* `main` *function.* 1b⟩≡

```
int main(int argc, char *argv[])
{
    ⟨Process given options. 2e⟩

    ⟨Print each string, separated by a space. 4f⟩

    ⟨Print a newline unless the -n option was given. 3a⟩

    return 0;
}
```

This code is used in chunk 1a.

Defines:
`argc`, used in chunk 4.
`argv`, used in chunk 4.
`main`, never used.

1a ⟨* 1a⟩≡

⟨*Include headers.* 2a⟩

⟨*Forward declarations.* 2c⟩

⟨*Define the* `main` *function.* 1b⟩

⟨*Define the* `usage` *function.* 2d⟩

Root chunk (not used in this document).

Include Headers

Include the core input and output functions from the C standard library.

2a ⟨*Include headers.* 2a⟩≡
```
#include <stdio.h>
```
This definition is continued in chunk 2b.
This code is used in chunk 1a.
Defines:
`EOF`, used in chunk 4c.
`printf`, used in chunks 2d and 4e.
`putchar`, used in chunks 3a and 4d.

Include the GNU `getopt` function from the GNU C Library.

"The `getopt` function gets the next option argument from the argument list specified by the `argv` and `argc` arguments. Normally these values come directly from the arguments received by `main`." – GNU, 2017

2b ⟨*Include headers.* 2a⟩+≡
```
#include <getopt.h>
```
This code is used in chunk 1a.
Defines:
`getopt`, used in chunk 4c.
`opterr`, used in chunk 2e.
`optind`, used in chunks 3d and 4f.
`optopt`, used in chunk 4b.

The `usage` Function

Define the `usage` function, which displays information about how to use `echo`, including ⟨*known options* 2f⟩.

2c ⟨*Forward declarations.* 2c⟩≡
```
void usage();
```
This code is used in chunk 1a.
Uses `usage` 2d.

2d ⟨*Define the* `usage` *function.* 2d⟩≡
```
void usage()
{
    printf("Usage: echo [-n] [string ...]\n");
}
```
This code is used in chunk 1a.
Defines:
`usage`, used in chunk 2c.
Uses `printf` 2a.

Processing Options

Set `opterr` to `0` to tell `getopt` not to print an error message upon encountering un⟨*known options* 2f⟩.

2e ⟨*Process given options.* 2e⟩≡
```
opterr = 0;
```
This definition is continued in chunks 3c and 4a.
This code is used in chunk 1b.
Uses `opterr` 2b.

`echo` accepts `-n` and prints other options.

2f ⟨*known options* 2f⟩≡
```
n
```
This code is used in chunk 4c.

`-n` *(do not print a trailing newline)*

Declare a variable `newline_flag` to determine whether or not to print a newline after printing the rest of the given strings.

3a ⟨*Print a newline unless the* `-n` *option was given.* 3a⟩≡
```
if (newline_flag)
    putchar('\n');
```
This code is used in chunk 1b.
Uses `newline_flag` 3c and `putchar` 2a.

When the `-n` option is given, set `newline_flag` to `0`, thereby disabling the printing of the trailing newline.

3b ⟨*Handle* `-n`. 3b⟩≡
```
case 'n':
    newline_flag = 0;
    break;
```
This code is used in chunk 4a.
Uses `newline_flag` 3c.

By default, print a trailing newline.

3c ⟨*Process given options.* 2e⟩+≡
```
int newline_flag = 1;
```

This code is used in chunk 1b.
Defines:
`newline_flag`, used in chunk 3.

Handling Unknown Options

If the user gives an unknown option, i.e. one not included in the ⟨*known options* 2f⟩, decrement `optind` by `1` in order to print it later.

"This variable is set by `getopt` to the index of the next element of the `argv` array to be processed." – GNU, 2017

3d ⟨*Handle unknown options.* 3d⟩≡
```
case '?':
    optind--;
    break;
```
This code is used in chunk 4a.
Uses `optind` 2b.

Looping Through Given Options

4a ⟨*Process given options.* 2e⟩+≡
```
int c;

while (⟨Process known options until EOF. 4b⟩) {
    switch (c) {
    ⟨Handle -n. 3b⟩
    ⟨Handle unknown options. 3d⟩
    }
}
```
This code is used in chunk 1b.
Defines:
c, used in chunk 4c.

Stop processing options when `optopt` is nonzero.

"When `getopt` encounters an unknown option character... it stores that option character in this variable." – GNU, 2017

4b ⟨*Process known options until* EOF. 4b⟩≡
```
!optopt
```
This definition is continued in chunk 4c.
This code is used in chunk 4a.
Uses optopt 2b.

Otherwise, process each known option as `c` until `EOF`.

4c ⟨*Process known options until* EOF. 4b⟩+≡
```
&& (c = getopt(argc, argv, "⟨known options 2f⟩")) != EOF
```
This code is used in chunk 4a.
Uses argc 1b, argv 1b, c 4a, EOF 2a, and getopt 2b.

Echoing Strings

Loop through `argv`, starting at `optind`, and ⟨*print a space* 4d⟩ between each string.

4f ⟨*Print each string, separated by a space.* 4f⟩≡
```
for (int index = optind; index < argc; index++) {
    ⟨Print the current string. 4e⟩
    ⟨Print a space unless the current string is the last argument. 4h⟩
}
```
This code is used in chunk 1b.
Defines:
index, used in chunk 4.
Uses argc 1b and optind 2b.

If `index` is less than `argc - 1` then ⟨*the current string is not the last argument* 4g⟩, so ⟨*print a space* 4d⟩.

4h ⟨*Print a space unless the current string is the last argument.* 4h⟩≡
```
if (⟨the current string is not the last argument 4g⟩)
    ⟨print a space 4d⟩
```
This code is used in chunk 4f.

4d ⟨*print a space* 4d⟩≡
```
putchar(' ');
```
This code is used in chunk 4h.
Uses putchar 2a.

4e ⟨*Print the current string.* 4e⟩≡
```
printf("%s", argv[index]);
```
This code is used in chunk 4f.
Uses argv 1b, index 4f, and printf 2a.

4g ⟨*the current string is not the last argument* 4g⟩≡
```
index < argc - 1
```
This code is used in chunk 4h.
Uses argc 1b and index 4f.

Full Listing

```c
#include <stdio.h>
#include <getopt.h>


void usage();


int main(int argc, char *argv[])
{
    opterr = 0;

    int newline_flag = 1;

    int c;

    while (!optopt && (c = getopt(argc, argv, "n")) != EOF) {
        switch (c) {
        case 'n':
            newline_flag = 0;
            break;
        case '?':
            optind--;
            break;
        }
    }

    for (int index = optind; index < argc; index++) {
        printf("%s", argv[index]);
        if (index < argc - 1)
            putchar(' ');
    }

    if (newline_flag)
        putchar('\n');

    return 0;
}


void usage()
{
    printf("Usage: echo [-n] [string ...]\n");
}
```

Chunks

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References

GNU. The GNU C Library: Using the getopt function. https://www.gnu.org/software/libc/manual/html_node/Using-Getopt.html, 2017. Accessed: 2017-11-05.